Autologous blood patch in persistent air leaks after pulmonary resection

Andrea Droghetti, MD,[a] Andrea Schiavini, MD,[a] Piergiorgio Muriana, MS,[a] Andrea Comel, MD,[b] Giuseppe De Donno, MD,[b] Massimiliano Beccaria, MD,[b] Barbara Canneto, MD,[a] Carlo Sturani, MD,[b] and Giovanni Muriana, MD[a]

Dr Droghetti

Objective: Persistent air leak is among the most common complications after pulmonary resection, leading to prolonged hospitalization and increased costs. At present there is not yet a consensus on their treatment.

Methods: During a 7-year experience, 21 patients submitted to pulmonary resection were postoperatively treated with an autologous blood patch for persistent air leaks. Persistent air leaks were catalogued twice daily according to the classification previously reported by Cerfolio and associates. Chest radiographs showed a fixed pleural space deficit in 18 (86%) patients. A total of 50 to 150 mL of autologous blood was drawn from the patient and injected into the chest tube, which was removed 48 hours after cessation of the air leak.

Results: We observed a 4% incidence of persistent air leaks after pulmonary resection in our series. Persistent air leaks were categorized as follows: 14% forced expiratory, 57% expiratory, 29% continuous, and 0% inspiratory. The mean duration of prolonged air leaks was 11 days after surgery. In 81% of the cases examined, a blood patch was only carried out once and gave successful results within 24 hours. In the remaining 19% of cases, the air leak ceased within 12 hours after the second procedure. Mean hospital stay was 15 days. In our experience this procedure had a 100% success rate.

Conclusions: Pleurodesis with an autologous blood patch is well tolerated, safe, and inexpensive. This procedure is an effective technique for treatment of postoperative persistent air leaks, even in the presence of an associated fixed pleural space deficit.

From the Thoracic Surgery Division[a] and the Pneumology Division and Intensive Respiratory Unit,[b] Carlo Poma Hospital, Mantova, Italy.

Received for publication April 12, 2006; revisions received May 22, 2006; accepted for publication May 23, 2006.

Address for reprints: Andrea Droghetti, MD, C. Poma Hospital, Thoracic Surgery Division, Viale Albertoni 1, 46100 Mantova, Italy (E-mail: ADroghetti@libero.it).

J Thorac Cardiovasc Surg 2006;132:556-9

0022-5223/$32.00

doi:10.1016/j.jtcvs.2006.05.033

Persistent air leak (PAL), defined as an air leak lasting more than 7 days, is among the most common complications after pulmonary resection, with an incidence of 3% to 25%.[1-8] The resulting prolonged hospitalization has negative economic effects, delays adjuvant treatment, and may have negative consequences on morbidity.

Pleurodesis has been performed by infusion of talc, bacterial components (OK432), antibiotics (tetracycline, doxycycline), and anticancer agents (mitomycin, adriamycin) with a success rate ranging from 60% to 94%.[9-12] In this article we discuss our 7-year experience during which autologous blood patch pleurodesis was adopted as a successful technique in 21 patients with PAL after pulmonary resection.

Patients and Methods

Between January 1999 and February 2006, 21 patients (19 men and 2 women) who underwent thoracic surgical treatment were submitted to autologous blood patch pleurodesis to treat persistent air leakage. This allowed us to obtain institutional review board approval to perform this procedure.

Abbreviations and Acronyms
PAL = persistent air leak

The median age at the time of surgery was 67 years (mean 61 years, range 22-83 years). Nineteen (90%) patients had a history of cigarette smoking, 13 (62%) had a past medical diagnosis of emphysema, and 6 (29%) had a history of steroid use (>10 mg of prednisone per day for at least 1 month before surgical treatment).

The following operations were performed: pulmonary resection for lung cancer in 14 (67%) patients, decortication for empyema in 2 (10%) patients, and lung volume reduction surgery for emphysema in 5 (23%) patients. Thirteen patients with lung cancer underwent lobectomies and 1 patient had a bilobectomy.

Air leaks were catalogued twice daily according to the classification reported by Cerfolio and associates[2] as expiratory, forced expiratory, inspiratory, or continuous. During the postoperative period, chest physiotherapy and incentive spirometry were carried out on all patients, and bronchodilators were also used when necessary.

On the basis of results from previous randomized trials, chest tubes were always placed to water seal 48 hours after surgery because this method is more efficient than wall suction for stopping air leaks.[2,13] Pneumothorax developed in 18 patients, whose tubes were then replaced on 10 cm H_2O of wall suction.

An air leak that persisted for more than 7 days was defined as a "prolonged air leak." As a matter of principle, an autologous blood patch was used for all patients with PAL after 10 postoperative days.

Chest radiographs at the time of pleurodesis showed a fixed pleural space deficit for inadequate expansion capability of the remaining lobe(s) to fill the hemithorax in 18 (85%) patients.

A total of 50 to 150 mL of peripheral venous autologous blood was drawn from the patient and injected into the chest tube (32F) with a 100-mL syringe under aseptic conditions. Blood was not heparinized. No sedation or analgesia was required. The tube was not clamped, but the extension tubing was draped 60 cm over the patient to prevent blood leaving the pleural space but allowing air to be evacuated. The patient's position on the bed was changed several times during a 1-hour period to help blood distribution into the pleural space. After 6 hours the water seal was reviewed to check for air leak. The next day, a chest radiograph was carried out. In those cases in which the blood patch failed and the air leak continued, the procedure was repeated after 48 hours.

The chest tube was removed 48 hours after cessation of air leak, and in those patients in whom pleural drainage was less than 200 mL it was removed after only 24 hours. After chest tube removal, all patients were monitored for clinical and radiologic evidence of pneumothorax or empyema. All data are reported with medians and ranges.

Results

The incidence of PAL after pulmonary resection in our experience was 4%. The leaks were classified as forced expiratory in 3 (14%) patients, expiratory in 12 (57%), and continuous in 6 (29%); no cases of inspiratory air leak were recorded. Mean duration of PAL was 11 days after surgery (median 11 days, range 5-13 days) (Table 1).

TABLE 1. Summary of patient data

Characteristics	No.	Range	Mean	Median
Patients				
Male	19 (90%)			
Female	2 (10%)			
Age (y)		22-83	61	67
Smoking	19 (90%)			
Chronic obstructive pulmonary disease	13 (62%)			
Steroids	6 (29%)			
Diagnosis				
Lung cancer	14 (67%)			
Enphysema	5 (23%)			
Empyema	2 (10%)			
Interventions				
Lobectomy	13 (62%)			
Bilobetomy	1 (5%)			
Lung volume reduction	5 (23%)			
Decortication	2 (10%)			
Air leaks				
Forced expiratory	3 (14%)			
Expiratory	12 (57%)			
Inspiratory	0 (0%)			
Continuous	6 (29%)			
Blood (mL)				
50	2 (10%)			
100	6 (29%)			
150	13 (61%)			
No. of injections				
1	17 (81%)			
2	4 (19%)			
Dead pleural space	18 (85%)			
Air leak after operation (d)		5-13	11	11
Air leak after blood patch (h)				
One injection		6-24	11	12
Two injections		6-12	10	12
Tube after blood patch (d)		2-6	2.8	3
Hospitalization (d)				
Postoperative		8-31	16	17
After blood patch		2-9	4	3
Total		10-44	16	15
Major complications	0 (0%)			
Minor complications				
Fever	2 (10%)			
Prolonged pleural effusion	1 (5%)			
Relapse	0 (0%)			

The lung was completely expanded before application of the blood patch in 3 (14%) patients, 18 (86%) had a fixed pleural space deficit, and 5 (24%) had enlarging subcutaneous emphysema at the time of pleurodesis.

The amount of blood ranged from 50 mL (2 patients, 9%) to 100 mL (6 patients, 29%) and 150 mL (13 patients, 61%).

In 17 (81%) patients one injection was sufficient to seal the PAL; 4 (19%) patients (2 with 50 mL and 2 with 100 mL) required two injections because the first was not successful.

The blood patch was carried out once on 17 (81%) patients, and within 12 hours no air leak was detected in the water seal in 15 (88%) of them; in the other 2 patients success was achieved within 24 hours (mean 15 hours, median 12 hours, range 6-24 hours). The procedure was repeated a second time in 4 (19%) patients 48 hours after application of the first blood patch, and air leak ceased within 12 hours. Chest tubes were removed 48 hours after the confirmation of no air leak. One patient was discharged with a Heimlich valve for prolonged pleural drainage (>200 mL per day), which was removed 7 days after pleurodesis. No pain, respiratory difficulty, cough, or major side effects were observed during the procedure. No significant decrease in hematocrit value was observed after removal of blood. No patient required a reoperation for air leak. No late empyema or other major morbidity was observed. In 2 patients submitted to decortication for empyema, low-grade fever lasting 1 day was observed after blood patch pleurodesis. One patient had to be transferred to an intensive respiratory unit for no invasive positive-pressure ventilation. The median hospital stay was 15 days (mean 16 days, range 10-44 days). Follow-up was completed in all patients with a median duration of 25 months (range 6-86 months). None has had recurrent pneumothorax or empyema. No operative mortality was observed. After 3 months, chest x-ray films confirmed complete re-expansion of the lung and no pleural drainage in all 21 patients. In no instances in our experience was this procedure unsuccessful.

Discussion

The incidence of PAL associated with pneumothorax and causing prolonged hospitalization in patients requiring pulmonary resection is 15.2%.[1]

Air leak after lobectomy usually ceases spontaneously if adequate re-expansion of the remaining lung is established. It is frequently treated by prolonged aspiration and use of the Heimlich valve, and most authors recommend pleurodesis with sclerosing agents such as tetracycline, talc, or OK432[9-12] before resorting to a rethoracotomy. However, chemical pleurodesis often fails and PAL with a fixed pleural space deficit remains. Furthermore, without adequate re-expansion, the sclerosing agent itself may prevent re-expansion of the remaining lung because of thickening of the visceral pleura.

Autologous blood patch pleurodesis has been reported in the literature by many authors as a procedure for PAL and pneumothorax with encouraging results. Robinson[14] was the first in 1987 to report an 85% success rate with this technique in chronic or recurrent spontaneous pneumothoraces. Subsequently, other authors reported their experience in short series of PAL after pulmonary resection or spontaneous pneumothorax.[15-23]

Our retrospective experience is the largest reported in the literature using this procedure for treating PAL after pulmonary resection. We observed a success rate of 100% in 21 patients.

A bronchoscopy can be warranted to rule out a bronchopleural fistula that requires different treatment, such as endoscopic or surgical closure.[24]

Timing to perform blood patch pleurodesis ranges between 5 days and several weeks in the literature.[15,21,23] At the beginning of our experience we performed blood patching after 10 days, but later we observed that if an air leak was present on postoperative day 5 there was a high probability (87% in our series) that it would be present on postoperative day 8 as well, so we proposed to use blood patch pleurodesis after 5 to 7 days to reduce the probability of pleural infection and to minimize delay of discharge.

Some authors reportedly inject no more than 50 mL of autologous blood to avoid introducing into the pleural space an ideal medium for bacteria that may be complicated by empyema.[23] The first 2 patients were treated by introducing 50 mL of blood, but a second injection was necessary because the first procedure did not result in successful sealing. Therefore, we subsequently increased to 100 mL of blood, and 2 of 6 patients required a second patch. In the last 13 patients of our series, we introduced 150 mL of blood directly with the first patch, and this procedure resulted in a complete success rate without any septic complication. We now recommend 150 mL of blood for all patients. Other authors exclude the use of this treatment in patients who have air leaks with incomplete lung re-expansion or residual pleural space because they fear that blood may represent a culture medium for bacteria with a high risk of empyema.[23] We want to underline that PAL in itself, even without a blood patch, increases the risk of empyema and that only one experience reports empyema after blood patch pleurodesis—a Turkish article reporting 3 cases (rate of 9%).[20] In our series, chest radiographs evidenced a fixed pleural space deficit in 18 (86%) patients at the moment of pleurodesis, all of whom were treated by a blood patch with success and without complication.

The sclerosing effect of blood is not as potent as that of other agents, but its mechanism may be based on three factors working together: irritation of pleural surfaces, reduction of fixed pleural space deficit by clot, and obliteration of alveolar-pleural fistulas by fibrogenic activity and patch-effect that contribute to re-expansion of the remaining lung.

Williams and Laing[25] reported a case of tension pneumothorax after blood patch pleurodesis using 12F (2.6 mm internal diameter) intercostal catheters. We did not observe this complication in our series after pulmonary resection,

perhaps because we used only chest tubes with a 32F diameter that were not clamped after instillation of blood but were raised above the patient, so that occlusion was not observed in any patient.

Blood pleurodesis has low costs, acceptable side effects, and a high rate of success. In our opinion this procedure should be considered in PAL before a reoperation, in patients with high risk of surgical morbidity and mortality, and before using other sclerosing agents. The blood patch is also effective in those difficult cases in which other sclerosing agents fail, probably because of residual pleural spaces.

Our experience confirms the success obtained with this procedure in previous cases as a treatment of PAL after pulmonary resection. We advocate randomized controlled trials to ascertain many unclear points of discussion, such as selection of patients, right timing, optimal quantity of blood, and comparison of results and costs with other procedures.

We thank Dr Anna Pierini for her help in preparing the manuscript.

References

1. Rice TW, Kirby TTJ. Prolonged air leak. *Chest Surg Clin North Am.* 1992;2:803-11.
2. Cerfolio RJ, Tummala RP, Holman WL, Zorn GL, Kirklin JK, McGiffin DC, et al. A prospective algorithm for the management of air leaks after pulmonary resection. *Ann Thorac Surg.* 1998;66:1726-31.
3. Stéphan F, Boucheseiche S, Hollande J, Flahault A, Cheffi A, Bazelly B, et al. Pulmonary complications following lung resection: a comprehensive analysis of incidence and possible risk factors. *Chest.* 2000;118:1263-70.
4. Abolhoda A, Liu D, Brooks A, Burt M. Prolonged air leak following radical upper lobectomy: an analysis of incidence and possible risk factors. *Chest.* 1998;113:1507-10.
5. Brunelli A, Monteverde M, Borri A, Salati M, Marasco RD, Fianchini A. Predictors of prolonged air leak after pulmonary lobectomy. *Ann Thorac Surg.* 2004;77:1205-10.
6. Isowa N, Hasegawa S, Bando T, Wada H. Preoperative risk factors for prolonged air leak following lobectomy or segmentectomy for primary lung cancer [letter]. *Eur J Cardiothorac Surg.* 2002;21:951.
7. Venuta F, Rendina EA, De Giacomo TE. Techniques to reduce air leaks after pulmonary lobectomy. *Eur J Cardiothorac Surg.* 1998;13:361-4.
8. Keagy BA, Lores ME, Starek PK, Murray GF, Lucas GL. Elective pulmonary lobectomy: factors associated with morbidity and operative mortality. *Ann Thorac Surg.* 2002;73:1727-31.
9. Almassi GH, Haasler GB. Chemical pleurodesis in the presence of persistent air leak. *Ann Thorac Surg*. 1989;47:786-7.
10. Alfageme I, Moreno L, Huertas C, Vargas A, Hernandez J, Beiztegui A. Spontaneous pneumothorax: long-term results with tetracycline pleurodesis. *Chest.* 1994;106:347-50.
11. Kennedy L, Rusch VW, Strange C, Ginsberg RJ, Sahn SA. Pleurodesis using talc slurry. *Chest.* 1994;106:342-6.
12. Ishihara K, Hasegawa T, Okazaki M, Katakami N, Sakamoto H, Lee E, et al. OK432 chemical pleurodesis as a standard therapy of spontaneous pneumothorax. *Nippon Kyobu Shikkan Gakkai Zasshi.* 1988;26:10-5.
13. Cerfolio RJ, Bass C, Katholi CR. A prospective randomized trial compares suction versus water seal for air leaks. *Ann Thorac Surg.* 2001;71:1613-7.
14. Robinson CL. Autologous blood for pleurodesis in recurrent and chronic spontaneous pneumothorax. *Can J Surg.* 1987;30:428-9.
15. Dumire R, Crabbe MM, Mappin FG, Fontenelle LJ. Autologous "blood patch" pleurodesis for persistent pulmonary air leak. *Chest.* 1992;101:64-6.
16. Mallen JK, Landis JN, Frankel KM. Autologous "blood patch" pleurodesis for persistent pulmonary air leak. *Chest.* 1993;103:326-7.
17. Yokomise H, Satoh K, Ohno N, Tamura K. Autoblood plus OK432 pleurodesis with open drainage for persistent air leak after lobectomy. *Ann Thorac Surg.* 1998;65:563-5.
18. Blanco I, Canto Argiz H, Carro del Camino F, Fuentes Vigil J, Sala Blanco J. Pleurodesis with the patient's own blood: the initial results in 14 cases. *Arch Bronconeumol.* 1996;32:230-6.
19. Blanco Blanco I, Sala Blanco J, Canto Argiz H, Carro del Camino F, Gorostidi Perez J. Pleurodesis with autologous blood: the results of a series of 17 cases with more than a year of follow-up. *Rev Clin Esp.* 1997;197:406-10.
20. Cagirici U, Sahin B, Cakan A, Kayabas H, Buduneli T. Autologous blood patch pleurodesis in spontaneous pneumothorax with persistent air leak. *Scand Cardiovasc J.* 1998;32:75-8.
21. Rivas de Andres JJ, Blanco S, de la Torre M. Postsurgical pleurodesis with autologous blood in patients with persistent air leak. *Ann Thorac Surg.* 2000;70:270-2.
22. Shackcloth M, Poullis M, Page R. Autologous blood pleurodesis for treating persistent air leak after lung resection. *Ann Thorac Surg.* 2001;71:1402-3.
23. Lang-Lazdunski L, Coonar AS. A prospective study of autologous "blood patch" pleurodesis for persistent air leak after pulmonary resection. *Eur J Cardiothorac Surg.* 2004;26:897-900.
24. Lois M, Noppen M. Bronchopleural fistulas: an overview of the problem with special focus on endoscopic management. *Chest.* 2005;128:3955-65.
25. Williams P, Laing R. Tension pneumothorax complicating autologous "blood patch" pleurodesis. *Thorax.* 2005;60:1066-7.